Analysing Teacher-teams by the Combing Chart

Scenario

At the start of the timetabling season, the Timetabler usually asks for, and receives, staffing details and timetable requests from the various heads of department.
The First Law of Timetabling states that: *these sets of data are almost certainly incompatible !*
The Second Law states: *Any incompatible data will force the Timetabler to make compromises during the actual scheduling stage of the timetable, and any compromises then are likely to damage the quality of the timetable !*

Quite often the timetable requests even for a single faculty are mathematically impossible. ie. each request may look reasonable, but taken together they may be mathematically incompatible and so it may be impossible to fit them into your school week.
A simple test allows us to check this.

The **'Combing Chart'** is a test for analysing your teacher-teams to see if they will fit into your school week.
This Combing Chart is particularly useful for enabling heads of department to analyse their own teacher-teams ***before*** submitting their timetable requests to the Timetabler.

Further reading: Chapter 5 in Keith Johnson, Timetabling (published by Stanley Thornes Ltd, ISBN 0-7487-1077-9). More details are given at **www.timetabler.com**

In-service Training Activities for your Staff

If you are the school or college Timetabler, you will find it particularly helpful to give your colleagues (particularly the Heads of Department) the short in-service training session described here. It can be done within an hour.

It gives your colleagues some insight into the problems of timetabling, and thereafter you will generally find it much easier to have discussions with your colleagues if you are negotiating with them to change some aspect of the timetable data.

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Course members can work individually or in pairs.

Activity 1 Introduction by you, the Tutor, using the Briefing (T1) with Factsheet (S1), followed by Course Members' activity (S2). Time: 25-30 minutes.

Activity 2 Summary by Tutor of Activity 1, and introduction to the Principle of Compatibility using Factsheet (S3), followed by the second activity for Course Members (S4). Time: 15-20 minutes.

Materials Checklist:

For the Tutor: OHP and transparencies of S1, S2, S3, S4; Sheet T1

For Members: a copy each of sheets S1, S2, S3, S4

Tutor Briefing T1

The Tutor will need to prepare by reading all the sheets (S1, S2, S3, S4) and then working though the activity-tasks.

The first task (sheet S2) uses imaginary data. Ideally the Tutor should also draw up a similar completed grid using real data from your school, as an example to show and discuss at the end of Activity 1. Of course the point will be better made if the real example cannot fit into the real week !

Introduction

Set the scene within the overall context of the Timetabler's year. Explain the advantages of checking the timetable requests from each faculty/department (perhaps by quoting the 'laws of timetabling' referred to earlier).

Emphasise that it is ***teachers*** that cause timetable clashes, not subjects.
That is, clashes are not introduced directly by the curriculum which has been laid down, but only indirectly by way of the teachers who are chosen to staff the groups.

Talk through Sheet S1 (using an OHP), emphasising how even a small department of only three people may be impossible to timetable in certain combinations, as the example on S1 shows. Time = 10 minutes.

Activity 1

Give out Sheet S2 and ask the Course Members to use the grid to answer the questions (working individually is better than working in pairs). Time = 15-20 minutes.

Display the answer on a prepared OHP of S2 by revealing it one team at a time.

(*Answers:* **1.** No, it needs 42 periods **2.** See Factsheet 2)

Activity 2

Summarise the findings and discussion of Activity 1, and then explain how this leads to a principle that can be used to choose the most compatible teams.
Uncover an OHP of Factsheet S3 *horizontally* so that progressive divisions of the teams can be clearly seen. Time = 5-10 minutes.

Give out Sheet S4 and allow the Course Members (individually or in pairs) 10 minutes, before discussing the answers.

(*Answers*: **1.** 6-team-B **2.** Speak to LL. **3.** AA, CC, EE, FF, LL **4.** AA, CC, EE and HH, II, KK)

Visit the web-site at **www.timetabler.com**
if you want in-service training materials on other aspects of timetabling,
or if you want to download **free** timetabling software.

Factsheet 1 **S1**

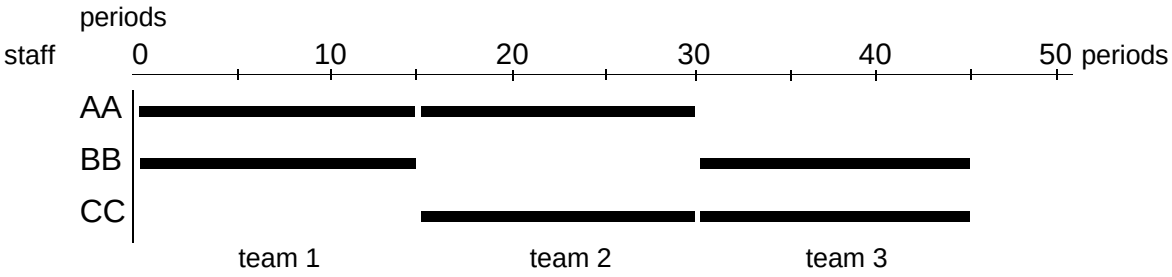
Analysing teacher-teams: The 'Combing Chart'

In building up the timetable, the Timetabler has to find ways to combine the many requests from different faculties/ departments into one coherent schedule.
This complex task is often made more difficult by heads of departments making requests which appear reasonable, but in fact are mathematically impossible.

For example, consider the apparently simple case of a Special Needs department of 3 teachers, called AA, BB, and CC, working in a school with a 40-period week.
The Head of Department makes the following requests:

Teachers:	AA *and* BB	to teach together for 15 periods each week	(team 1)
	AA *and* CC	to teach together for 15 periods each week	(team 2)
	BB *and* CC	to teach together for 15 periods each week	(team 3)

To see if this is a reasonable request, we can draw a **time chart:**

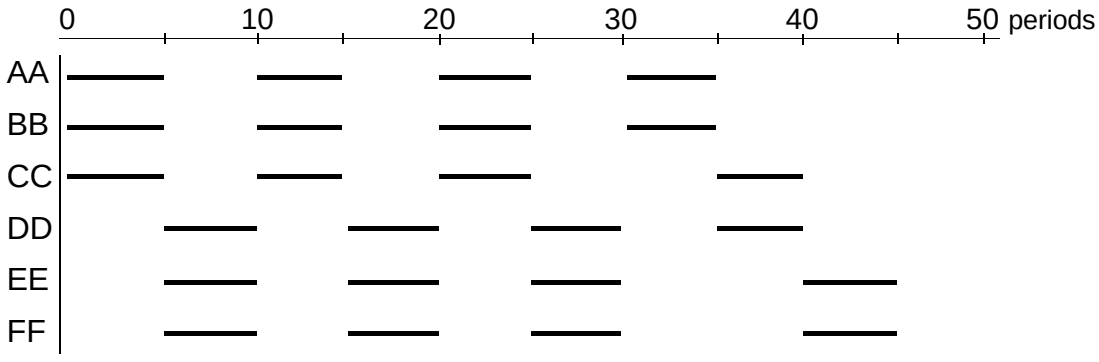


This apparently simple request is mathematically *impossible* to timetable within a 40-period week, even though each teacher teaches for only 30 periods !

Applying a pre-timetable check like this can prevent a great deal of frustration at the scheduling stage. More importantly, it allows the Timetabler and the Head of Department to see *why* the request is impossible, and to discuss solutions clearly and logically.

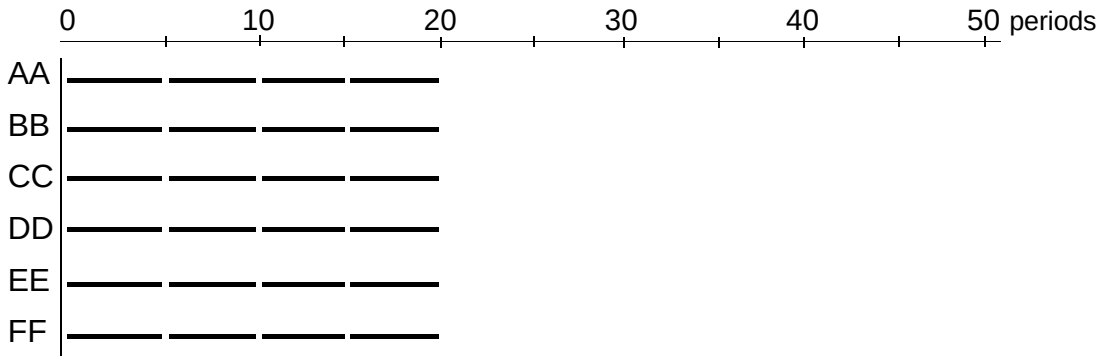
This kind of time-chart is often called a '**Combing Chart**', because the bars representing the teacher-teams are like the teeth of a comb, which prevent the teams from being combed to the left into a shorter period of time.

For another example, here are the teacher-teams for a well-organised Maths department of 6 teachers, AA, BB, CC, DD, EE, FF.



continued . . . .

Because of the careful and compatible way in which this Head of Department has chosen these teams, they can easily be combed to the left so that they all fit within only 20 periods:



The teams fit against each other so that they can be ‘combed’ to the left.
The greater the space to the right, the greater the flexibility for the Timetabler.

The golden rule is this: ideally the whole department should comb down into the same number of periods as the maximum teaching load of any individual.

For example, if the maximum teaching load of any teacher in the department is 20 periods (eg. in a 25-period week) then the whole department should comb down into 20 periods, as in the diagram above.

If the Maths Department does not comb down well, and if the other departments don’t comb down well, then when they all interact and try to fit together on the timetable, the solution space may be very tight or impossible.

For more details about timetabling, and free software, visit the web-site at:
www.timetabler.com

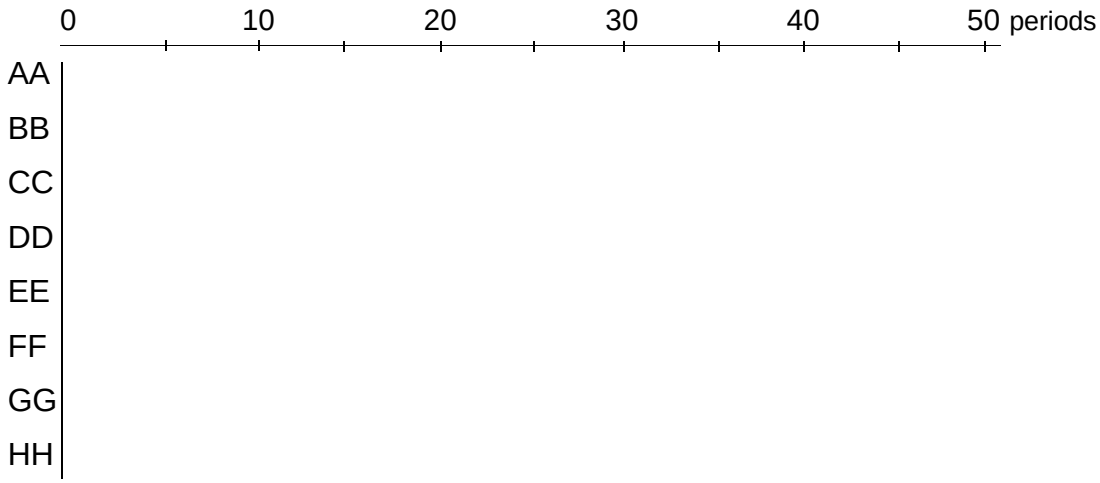
Activity 1 S2

The English Department at Laura Norder High School consists of 8 teachers, labelled as: AA, BB, CC, DD, EE, FF, GG, HH.

The Head of English (teacher AA) makes the following requests to the Timetabler:

Class:	periods:	Teachers:
11A	8	AA, BB, CC, DD
11B	8	EE, FF, GG, HH
10U	8	AA, BB, CC, HH
10L	8	AA, EE, FF, GG
9P	6	AA, BB, CC, DD
9Q	6	EE, FF, GG, HH
8X	6	BB, CC, DD, EE
8Y	6	DD, FF, GG, HH
7C	4	BB, CC
7D	4	GG, HH
7E	4	DD, EE
7F	4	DD, FF

Use the grid below to draw a Combing Chart for this English Department. (You may wish to use pencil initially)



Q1. Can this English department be timetabled into a 40-period week ?

Q2. How may the situation be improved ? ie. what teacher-exchanges would you urge the Head of English to make, in order to make the teams more compatible?

Q3. Now draw a Combing Chart for your own faculty/department, perhaps using last year's staffing allocations. Look particularly to identify those teachers who prevent teams from combing to the left. How could it be improved ?

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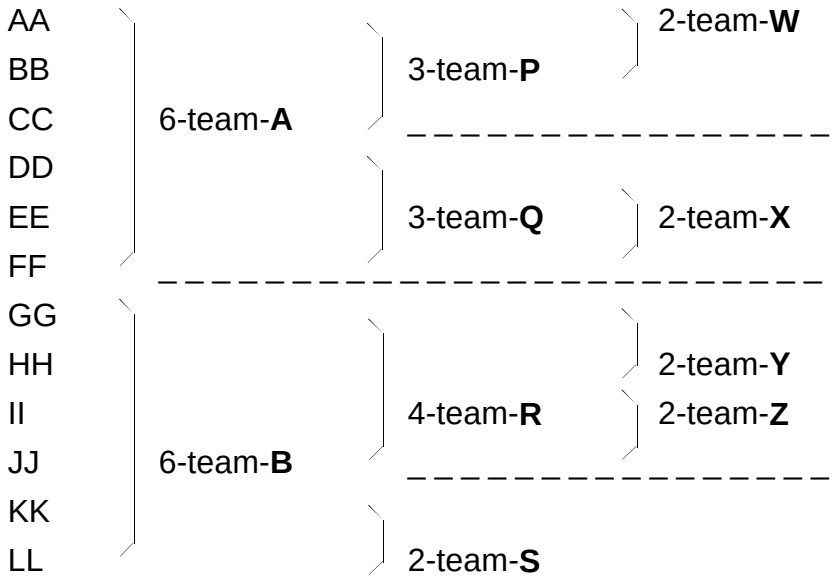
Factsheet 2 **S3**

Selecting Teacher-teams

In the light of the previous activity, let us see how a department might choose ***ideal*** teacher-teams.
Consider a large Science department of 12 teachers, named AA, BB, CC, ...LL.
Suppose that for one of the year-groups we need a team of 6 teachers. There are many ways of choosing 6 teachers, but suppose we choose the first 6 teachers: AA, BB, CC, DD, EE, FF. This is marked as 6-team-**A** in the diagram below.

Suppose now that we need another team of 6 teachers for another year-group. If we want to choose non-overlapping teams, that will easily comb to the left on a Combing Chart, then there are only two possibilities. Either we choose the team of the *same* 6 teachers (6-team-A), or we choose the team of the ***other*** 6 teachers (6-team-B).



When choosing smaller teams, the same principle applies.
For example, a 3-team should be chosen from ***within*** one of the 6-teams. In the diagram, 3-team-P could be timetabled at the same time a 6-team-B (whereas if we had chosen a 3-team of teachers AA, DD, HH it would clash with both team-A and team-B).
Similarly, 2-teams should be chosen from ***within*** 3-teams.
In the diagram, the horizontal lines show the boundaries which should not be crossed.

In choosing teams from within teams like this we are selecting 'disjoint subsets'.
The principle we are using is called the **Principle of Compatibility** :
to fit teacher-teams into the minimum number of periods, with the maximum flexibility, disjoint subsets should be chosen.

Of course the rigid application of this principle is the ideal.
In practice there will be sound educational reasons which prevent the teams being chosen from being entirely non-overlapping -- but every such case causes a loss of flexibility for the Timetabler, and heads of department should always aim to apply the principle of compatibility as far as possible.

Activity 2 **S4**

Choosing Teacher-teams

Imagine you are the Head of the Science Faculty at the Laura Norder High School.
The faculty is composed of 12 teachers named AA, BB, CC, ... LL.
The timetabling of your faculty has been difficult and unsatisfactory in recent years, and you resolve to improve the situation.
Teachers AA, CC, EE, FF, JJ, LL are due to continue with their classes into the new Year 11 (as a team of 6, across the whole year-group) -- see the diagram below.

1. You need to choose a team of 6 teachers to teach the new Year 10.
What are the alternatives ?
Which is the better alternative ?

2. You remember that you promised teachers BB and LL that they could teach the new Year 10.
What do you do ? What reason do you give ?

3. For the new Year 9, you need to choose a team of 5.
Teachers HH and JJ also teach mathematics and they have full timetables.
Teacher EE is the Year Tutor for Year 9.
Which team of 5 would you choose ?

4. Some 3-teams are needed for the half-year-groups in years 7 and 8.
Two of the teams already chosen are: FF, JJ, LL and BB, DD, GG.
What other 3-teams are then possibilities ?

5. A colleague proposes that science in Year 8 is taught by a team of 7 teachers.
What is your response ?

1	AA	
2	CC	
3	EE	6-team-A
4	FF	
5	JJ	
6	LL	
7		
8		
9		
10		
11		
12		

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